USING CLOUD COMPUTING IN HIGHER EDUCATION

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Abstract. Information Technology today is becoming an integral partner in modern higher education. We are witnessed of the changes that occurred by using of this technology in the classroom. But, despite the constant improvement of performance and price, the total cost of IT is still going upwards, mostly because of the need of teachers and students of the newer and more powerful machines, and audio-visual aids. Working in times of financial crisis and in conditions of steady growth needs, universities are facing with difficulties in providing necessary information technology (IT) to support education, research and development activities. In these conditions educational institutions very quickly embraced cloud computing strategies and acceded to their implementation to their own needs. Although there are still obstacles to the full implementation of the cloud model, the potential benefits greatly outperform other risks that arise. Changes that occur require a new way of managing with information technology and also staff with responsibilities. As this model is developed and the risks are lower, most institutions are more intensely to adopt and implement according to their needs and conditions. The purpose of this paper is to present alternatives to the use of information technology in order for university to improve the overall educational process by reviewing the methods of using the model in higher education.

Keywords: information technology, cloud computing, higher education

1. Introduction

In these modern times the expression "Cloud computing" is being used a lot, but there is a lack of clarity about what cloud computing is. A study by McKinsey [12] found that there are 22 possible separate definitions of cloud computing [9, 19]. In fact, no common standard or definition for cloud computing seems to exist. Most of us are using the cloud on everyday basis without even realizing that this is the case [2,7]. Using our Gmail or Hotmail accounts, or uploads a photo to Facebook, we are using the cloud. The potential

benefits and risks, however, are more visible [17]. The cloud can be described as on-demand computing, for anyone with a network connection. Access to applications and data anywhere, anytime, from any device is the potential outcome. In practice, cloud computing as implemented is substantially more complex than the user perspective of it suggests, and many of the potential benefits of the cloud actually stem from this. Many of the perspectives on the cloud adopt a 'layers' view to describe it MIT Technology Review briefing [15].

In the last couple of years the concept of cloud computing has emerged as a practical and promising resolution to the challenges in the reduction of IT budgets and the growing of IT needs. Journals, conferences, consulting firms, and service providers dedicated to cloud computing services and strategies have sprung up virtually overnight which has increased exposure, attention and promise to address IT budget deficit. Despite this creation of cloud computing resources and interest in such resources, for some IT leaders and institutional administrators, the solution is still far away [6, 8]. Most of the concerned sides say that there is too much propaganda but not enough adequate research and convincing case studies to fully commit resources and funding to move in this direction. Others are more troubled about the security and data protection [14]. The commitment to this model fundamentally will change the way of working of IT groups in universities, their power and influence, and their function and view of assessment within the institution.

In many terms the primary advantages the cloud brings are to do with cost and efficiency, which are closely observed. The capital costs of computing can be resolved if an organization relies on the public cloud, buying virtual server time and storage space on demand. Expenditure on IT becomes operational, rather than capital. Moreover, the physical space required for tiers of servers is no longer essential and the organization no longer acquires energy costs for running and cooling its servers. For many start-up businesses, cloud computing offers access to computing power that would otherwise be beyond their reach. The entry barrier for large-scale computing task is effectively removed by the cloud. As costs are incurred on a per use basis, the risks of committing to large capital purchases are removed. Scalability allows the organization to add capacity as and when it's needed and to scale down as well as up, driven by demand [17].

Even if ditching all physical servers is seen as a step too far, building a private cloud with virtualized servers, even if the organization owns and maintains the physical infrastructure, can deliver large efficiency gains. A McKinsey survey cited by The Economist [12] suggests that, without virtualization, on average only 6% of server capacity is used. However, the kinds of economies of scale that large cloud providers can take advantage of will typically be absent. Nonetheless, in this private cloud approach an organization can still take advantage of the on-tap computing power in the public cloud. 'Cloud bursting' is a service that provides 'overflow computing' for dealing with spikes in web traffic or processing load [15]. Flexibility, as well as cost, is another compelling advantage of the cloud. As Erik Brynojolfsson [1] of MIT states, "The ability to be agile in your infrastructure is what separates the winners from the losers… cloud computing is one of the most important technologies that affect the ability to maintain that level of

flexibility". The paper is structured in two parts: theoretical and practical. The theoretical part presents the importance of the cloud computing in higher education and its benefits. In practical part we present our 3 types of learning management systems which are implemented in our faculty.

2. Cloud Computing In Higher Education

The Higher education around the globe is constantly evolving, generally as a result of important challenges arising from efforts to adopt new technologies and pedagogies in their classrooms. This is mainly as a result of a new genre of students with learning needs vastly different from their predecessors, and it is increasingly recognized that using technology effectively in higher education is vital to providing high quality education and preparing students for new challenges.

Many technologies that were previously expensive or unavailable are now becoming free when using the World Wide Web. This is true for all web sites, blogs, video sharing, music sharing, social sharing, collaboration software, editing/presentation and publishing, and computing platforms in the "cloud". Students are already using many of these technologies in their personal lives. In the professional world, the trend of discovering and using technologies in our personal life is called "consumerization" [6]. This means we should demand and consume the required services. Our education system should take advantage of this situation, which will improve student's education and reduce the spending of the academic institutions. Universities should identify and control technologies that are cost-effective, and try hard to offer realistic and reasonable access to technology for students and staff. The need for hardware and software isn't being eliminated, but it is shifting from being on-premises to being in the cloud. All that is needed is a cheap access device and a web browser, internet connection in the facilities, perhaps wireless hotspots.

According to the CDW 2011 Cloud Computing Tracking Poll [3], 28 percent of organizations use some form of cloud computing. By industry, 37 percent of large U.S. businesses employ cloud computing strategies followed by 34 percent of higher education institutions in the U.S. This latter figure may not be accurate as another 2011 survey which revealed that as many as 63 percent of those completing the survey representing higher education reported that they were confused regarding the differences between cloud computing and virtualization [18]. Regardless, a growing number of higher education institutions in the U.S. are adopting some form of cloud computing for various reasons and only 5 percent are not considering it in the near future [3]. Many of the researchers [11] in this filed identify 10 important features of cloud computing in higher education with respect to on demand services:

1. Increasing access to scarce IT expertise and talent.
2. Scaling IT services and resources.
3. Promoting further IT standardization.

4. Accelerating time to market through IT supply bottleneck reductions.
5. Channeling or countering the ad hoc consumerization of enterprise IT services.
6. Facilitating the transparent matching of IT costs, demand and funding.
7. Increasing interoperability between disjoint technologies within and between institutions.
8. Supporting a model of a 24 x 7 x 365 environment.
9. Enabling the sourcing of cycles and storage powered by renewable energy.
10. Driving down capital and total costs of IT in higher education.

Institutions will gain the benefits of cloud computing in varying degrees upon their level of operation and degree of service models. As institutions become further engaged in cloud computing, they will be able to realize greater advantages, such as increasing access to scarce IT expertise and talent, promoting further IT standardization, the transparent matching of IT costs, demand and funding, and increasing interoperability between disjoint technologies within and between institutions. Using a scalable 24 x 7 x 365 model can drive down the capital and total costs for IT. The utility model is a pay-as-you-go model of cloud computing and is a welcome strategy and cost-saving measure for institutions of higher education in the face of rising IT costs and decreasing IT budgets. Services and computing resources are deployed in the cloud on a pay-per-service basis, thereby avoiding capital costs and internal operational expenditures. This way institutions can make adjustments every time they file like to increase or decrease capacity. There are numerous examples of when institutions need IT cloud resources scaled to meet temporary needs. For example:

- Enrolment of students;
- Organizing conferences and provide IT support and Internet access for conference participants;
- Distance learning support;
- Final examination period when thousands of students simultaneously need access to computing resources and exams;

3. The Challenges Of Cloud Computing In Higher Education

Despite the growing acceptance of cloud computing and documented cost savings made possible by cloud computing in higher, concerns about the vulnerability to security breaches are the biggest obstacles to cloud computing adoption in higher education [10, 18]. The most important of these security risks includes the loss of authority, lock-in issues, isolation failure, compliance risks, management interface compromise, data protection, incomplete or insecure data deletion and malicious insiders [2]. In addition, concerns regarding privacy, data integrity, intellectual property management, regulation issues (e.g. HIPAA and FERPA), and audit trails are significant barriers to adoption of cloud-based solutions [4, 5].

Consequently, risk assessment becomes a critical task, although some argue that many of the risks related to cloud computing is transferred to the cloud vendor/service provider [16]. To help diminish these risks for higher education institutions, several organizations have emerged in the last few years. The Cloud Security Alliance was launched in 2009 as a non-profit organization tasked with conducting research in cloud security and offering information and resources about best practices in security protection in cloud computing [4, 5]. The Higher Education Information Security Council, a subgroup of EDUCAUSE, provides membership, comprehensive resources and engages members in an ongoing dialogue and issues, challenges and solutions in this area. As noted above, EDUCAUSE [4] also has a dedicated area on its website for cloud computing issues in higher education complete with publications, presentations, podcasts, blogs and news feeds.

Similar to computer security programs, cloud security involves the same general concerns: maintaining the integrity of data, ensuring access is limited to authorized users and maintaining the availability of data and services [4, 5]. With cloud computing, the data and services are external to the campus and therefore controlling and protecting these assets becomes a much more complex and challenging proposition. Data encryption, e-discovery, frequency and reliability of data backups and recovery of data, the long-term viability of the cloud vendor and laws regarding storage and access to data all become critical issues. Typical service level agreements that cloud vendors provide are not specific and detailed enough to meet college and university requirements. Fortunately, through the Higher Education Information Security Council, a toolkit called the Data Protection Contractual Language is available to provide guidance and languages to assist institutions in crafting appropriate SLAs and contracts to meet their specific needs. This is an evolving area, and although much progress has been made, much more is needed before colleges and universities can place their complete trust in these third party cloud vendors. As increasing numbers of institutions move to the cloud, their collective bargaining power will help them create appropriate policies and contracts to meet their needs.

4. The Alternatives Of Cloud Computing In Higher Education

NIST [13] also describes three service models: Cloud Software as a Service, Cloud Platform as a Service and Cloud Infrastructure as a Service.

The differentiators among these three service models are the nature of the service and the level of customer-vendor control and engagement. Furthermore, it should be noted that these models are not mutually exclusive; organizations can and do employ different cloud service models on varying scales for different departments within the organization based on specific needs.

In model Cloud software as a service (SaaS), the vendor provides, manages and controls the underlying cloud infrastructure, including individual applications, network, storage, servers, operating systems, etc. The customer is able to fully access the vendor‘s

applications in the cloud via a variety of devices (e.g. cell phone, laptop, PDA). SaaS examples include MyErp.com, Salesforce.com and Workday.com. Google Docs, Twitter and Facebook also fall into this category.

In the Cloud platform as a service (PaaS) model, similar to SaaS, the vendor provides, manages and controls the cloud infrastructure, except for applications, which the customer has control over. The vendor provides tools and resources allowing the customers to create and/or acquire applications to meet their specific needs. PaaS vendor examples include Wolf Frameworks, Dell-Boomi Atmosphere, Heroku, Google App Engine and Microsoft‘s Azure [20].

Cloud infrastructure as a service (IaaS) model means that vendor provides, manages and controls the general cloud infrastructure but provides the customer control over operating systems, storage, processing, and networks on demand. IaaS vendor examples include Flexiant‘s Flexscale, Rackspace and Amazon‘s Elastic Cloud Compute (EC2) and their Simple Storage Service (S3).

The case study we take in consideration is the implementation of learning management system – efront in the classes of web programming course in our faculty. The software is installed on the faculty’s server as intranet solution, but it can be installed also on the web environment as cloud. In the fig.1 the used screens are shown and we can see the possibilities of the proposed solutions.

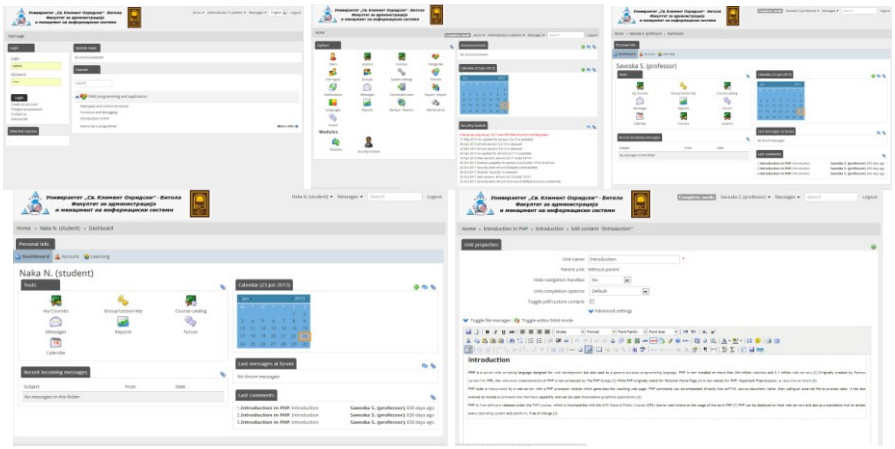

Fig. 1. Efront screen shoots: Home page, administrator dashboard, professor dashboard, student dashboard and screen for editing lessons of the intranet platform

Also, we implemented another two different platforms, SaaS with Google site possibility and IaaS with creation of own e-learning system with usage of own content management system.

The Google site is created for the needs of students which learning course of Analysis and design of information systems in our faculty. This site can be created with templates offered by the provider and it is restricted on the given possibilities. Design of created site is shown on screen shoots in the fig.2.

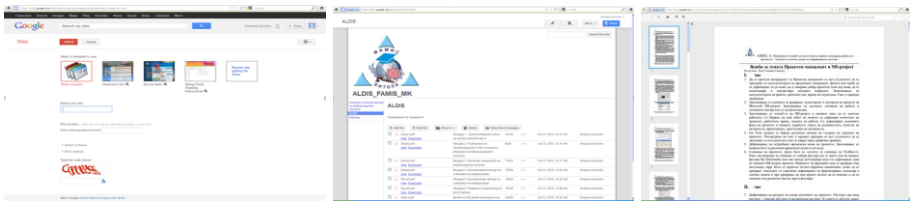

Fig. 2. Creating a new Google sites, screen shoots with lessons and editing the lessons

The third possibility which we used is creation of own e-learning system, created for specific purpose of final bachelor work. It is some kind of content management system, created in PHP with MySQL database which can be uploaded on dropbox. We can use it as the repositories which will content the course's lessons. For all users (professors), the usernames and passwords can be created and they can put their lessons on the site. Students can have a free assess or restricted, depends on the contraction with the professors. The lessons can be protected with passwords or with lessons' entry codes. The screen shoots of this solution is shown on the fig.3.

Fig. 3. Creating a own content management system, uploaded on dropbox, form user login, staff menu and the appearance of the posted lessons

This proposed solution has own benefits – we can design the site as we want, without restrictions of proposed solutions as in the Google sites or with efront solution. Design of this kind of solution depends only of the programmer's invention and knowledge or the users' demands. We can use all of three concept separate or integrated depends of the courses, number of students on the courses or the demands of professors or students. Each of them has advantages and disadvantages accompanying with some specific form of learning as the practical work or task solving, communication possibilities or mutual work and depends on these reasons the solution can be selected.

5. Conclusion

Cloud computing is an emerging computing paradigm which promises to provide opportunities for delivering a variety of computing services in a way that has not been experienced before. It was demonstrated in this article how educational institutions are already taking advantage of the benefits which this technology is bringing, not only in terms of cost but also efficiency and the environment. It was argued in this article that educational establishments are likely to embrace cloud computing as many of them are bound to suffer from under-funding due to the global economic crisis. In some parts of the world, such as our region, cloud computing is emerging as an empowering tool that is being used to advance the cause of education in the Balkan countries. Conventional perception dictates that cloud computing, as explained in this article, is unlikely to be suitable for education. However, recent research and real-life examples suggest that this view may no longer be valid. Like many new technologies and approaches, cloud computing is not without problems. There are many concerns relating to its security and reliability.

However, before that stage is reached, more work is required in order to address the concerns that currently prevent some organizations from embracing cloud computing.

We can use different approaches of the usage of cloud computing in the higher education process, depends on the professors' and students' needs and the type of courses and way of learning. All of these solutions have advantages or disadvantages which are associated with the level of practical work or possibilities of problem solving in the courses. Selection of the solution is specified with the preferences of the specific course.

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